

the fabric engineer

february 2001

 **RUBB**

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welcome to the fabric engineer

The year 2000 was another year of progress and new milestones for the Rubb group. We have established Rubb TM Limited in Southern England and have built our first pure tension membrane structure.

At Rubb Buildings Limited in England we have delivered a 90' span hangar for Scot Airways and developed a brand new range of Rapid Deployment Shelters (RDS) which will enable us to offer a complete range of shelters to emergency relief and military organizations. 115 of these shelters have already been delivered to the United Nations.

At Rubb, Inc. in the USA we have erected the largest clear span Rubb facility to date. This is a 255' wide, 4-5 million cubic foot, hangar for United Airlines at Logan International Airport in Boston. In addition, Rubb, Inc. has delivered one of the highest sidewall fabric structures to date to Intermarine Shipyard in Savannah, Georgia. Vertical sidewalls are 58' with an overall maximum height of 73'.

In Norway we have a new range of water tanks with an innovative design which improves handling and lowers production cost. We have also added to our range of water weights by producing and testing a 10 ton Rubb Aquaweight.

Finn Haldorsen

Finn Haldorsen
Group Chairman

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The life span of a building depends on many factors including environmental conditions, the corrosion potential of materials stored inside the structure, the initial quality of the structure's components and many other factors.

For anyone considering a steel framed building, careful thought must be given to the construction materials being proposed by the supplier.

For example, there are three primary manufacturing processes that can be employed to produce the completed framework of a steel framed fabric building. The quality and longevity of the finished structure is highly dependent on the method chosen.

1. Painted Black Steel Framework - In this process the steel framework is welded together and then painted before being erected on site. Paint coatings are highly susceptible to chipping, particularly during handling and transportation and this damage results in the need for field touch up. Paint coatings, especially single coat prime finishes are generally inferior to galvanized finishes.

2. Pre-Galvanized Steel Framework - Many steel mills offer tubing which is galvanized immediately following the tube rolling process to an ASTM G60, G90, or equivalent specification. During fabrication the pre-galvanized tubes are first bent or welded together and then the areas of damaged zinc



Typical truss framework for a Rubb structure

What is the life of a STEEL FRAMED fabric clad facility?

coating are painted to prevent corrosion. This process is used by several fabric building manufacturers and the main benefit is a reduced cost. However, the painted weld areas are highly susceptible to rust and the result is a more limited life span, unsightly appearance and the potential for corrosion of points of high stress. In addition, this method usually involves a thin zinc coating on the exterior surface of the tube only.

3. Hot Dip Galvanized Framework - In this process black steel is welded together to form a complete fabricated piece. The fabrication is then hot dip galvanized to ASTM A123 specification to provide a zinc coating on all steel surfaces. This process involves full immersion of the structural fabrication in a molten zinc bath and provides a much thicker zinc coating than that of pre-galvanized products. In most environments, the hot dip galvanized coating used by Rubb will be expected to last a minimum of 40 years before initial maintenance is required.

Rubb hot dip galvanizes all welded fabrications in its structures to provide for superior corrosion protection. As the frame is fully galvanized after manufacture there is no paint to chip, no potential weak spots where rust can develop and the thicker zinc coating provides for superior long term performance. For extremely harsh environments, Rubb can offer duplex coatings which consist of hot dip galvanized steel that is painted or powder coated following the galvanizing process to provide extra protection.

When considering choices of fabric cladding the longevity issue becomes even more complex. There are many different types of fabric and fabric coatings to choose from and care must be taken to ensure that comparisons are being made on a like for like basis.

Rubb uses only the highest grades of PVC coated flame retardant high tenacity polyester produced by experienced suppliers using the best compounds, flame retardants and UV inhibitors.



Parts warehouse for a major motor company in the UK

For structures up to 39-4' span Rubb utilizes a 21 ounce/square yard material, larger structures use 28 ounce material. These materials offer significant life expectancy advantages over lighter weight laminates, polyethylene, and lower quality coated products.

The fabric cladding on Rubb structures can be expected to last up to 25 years before replacement becomes a consideration, although this is dependent on a number of factors such as environmental conditions. An excellent example of a long-lived Rubb building is a structure built in 1975 for Peck & Hale in New York which had its PVC cover replaced in the year 2000. Outside laboratory testing of a sample of fabric taken from that building confirmed that the fabric's self extinguishing and flame retardant characteristics were still present and that the original tensile strength had been maintained. After 25 years the physical deterioration was limited to a slight reduction in the fabric's tear strength and to general stiffening of the material due to long term plasticizer migration.



Rubb Passes the Hurricane Test

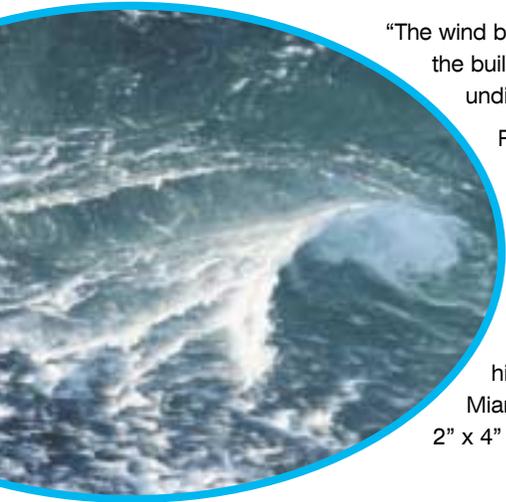
Rubb is in the business of providing solutions to weather protection problems including high force winds. This fact was apparent in October when Hurricane Keith hit the Gulf of Mexico and a 115' span Rubb BVL range building.

Robert Harrold of Mineral Processing and Marketing, Inc. (MPM) provides the following comments: "The Port of Altimira took a direct hit from Hurricane Keith at noon on 5 October with very heavy rain, a six foot storm surge and sustained winds in excess of 90 miles per hour. The eye of the storm was calculated to have passed directly over the Port causing severe flooding, downed power lines and extensive property damage. However, one structure that withstood the ordeal completely intact was Intermodal Transfer's Rubb Building Warehouse."

"The wind blew so hard that it even uprooted trees that had been planted along the sides of the building, but the building itself and over \$3 million of magnesite and other products stored inside, were completely undisturbed."

Rubb building range products are typically designed for a basic wind speed of 90 mph and can be engineered to significantly higher loadings upon customer request. The Rubb design, developed through sophisticated computer modeling, offers the highest structural integrity available in the relocatable building industry and is characterized by a fabric membrane tensioned over a steel frame to provide a drum tight shell which resists high wind and also holds heavy snow loads.

The Rubb building came through Hurricane Keith in good form, however not everyone is prepared to take our word on the strength and tenacity of a Rubb relocatable fabric building. This was highlighted when Rubb was recently contracted to provide an air cargo facility for United Airlines at Miami International Airport. The fabric cladding and attachment system were required to pass rigorous 2" x 4" large object impact and cyclic testing before the go ahead was given by the Miami authorities.



Rubb's capability, flexibility, and speed - the key for INTERMARINE

A unique "relocatable" Rubb structure has proven to be the perfect solution for protecting luxury yachts from inclement weather while they are undergoing maintenance and refitting at Intermarine's shipyard in Savannah, Georgia.

Rubb USA designed, fabricated and installed four 83' long modules to provide a 72' x 333' enclosure for Intermarine's graving dock. The largest sections of the Rubb enclosure have 58' sidewalls and an interior peak height of over 73' from the top of the graving dock.

The entire Rubb structure is mounted on rollers to allow its four

sections to be moved to accommodate Intermarine's operational requirements. The two smaller sections of the Rubb enclosure are designed to "telescope" inside the two larger sections to reduce the overall building footprint and to provide maintenance access to the graving dock.

Each of the four 83' modules has a 14' x 14' sliding door on each side, providing easy access for material handling and multiple gangway locations. The water side door consists of five stacked panels which slide into steel beam guides and allow complete access into the water side end of the structure. The rear gable has a 22' x 25' roller shutter door to provide access and to allow ship alignment during docking.

The hot dip galvanized steel frame is covered with a high quality PVC coated polyester membrane which provides superior corrosion protection in the marine environment and the entire Rubb structure is light enough to be readily moved. The structure was designed to be fully compliant with local building codes in an area which is prone to hurricanes.

As Intermarine's Mr. Jim Stribling commented: "We are delighted with this new facility and especially the short time it took to complete the project. Construction only took six weeks."



58' vertical sidewalls - the highest to date for Rubb

25 years of LOYAL SERVICE

Olaug Fjelheim (left) and Margunn Rølsnes were awarded gold watches for 25 years of loyal service to Rubb Norway last year. Nine other Rubb Norway employees have served more than 25 years with Rubb. All have been, or are, very valued employees and have provided great continuity of service in both quality and productivity to Rubb.



Rubb says thank you to Olaug and Margunn

25 year facelift for STORAGE FACILITY

A relocatable Rubb building measuring 33' x 70' has celebrated 25 years in service with a new PVC replacement cover for its hot dip galvanized steel frame.

The original structure was installed in 1975 for Peck & Hale, in West Sayville, New York, and was manufactured by Rubb Norway prior to the startup of Rubb USA in 1983.

A sample of the 25 year old fabric was sent for laboratory testing which confirmed that its flame retardant characteristics were still present. The original tensile strength specification has also been maintained. Only the fabric's tear strength has been slightly reduced after 25 years.

"Although the fabric was 25 years old, the facility at Peck & Hale could have carried on for many more years had the membrane cover not been affected by operational damage rather than the aging of the fabric", commented John Poulin, Rubb, Inc.'s Sales Manager.

As a matter of note, Peck & Hale has a second Rubb structure of similar size and age at their location which is still in good condition.



Membrane replaced after 25 years - not because of age, but due to operational damage

TAKE OFF FOR RUBB TM



Lawn Tennis in Huddersfield, UK now under cover

The year 2000 has seen creation of a new Rubb company. Rubb TM will specialize in the design and production of creative canopy designs and other unique tension membrane structures.

Rubb TM is located in the UK and is headed up by Adrian Billingsley who has been working in tensile structures since 1990 and has been involved in the completion of numerous projects around the world such as the Saudi Arabian Expo Pavilion at Seville, Spain, a geodesic sphere in Oman, and the tensile entrance at the Beijing aquarium and hospitality units at Lords Cricket Ground, UK.

The company is experiencing considerable success with architects and designers alike as tension membranes serve a variety of applications such as covers for cafe roofs, shelters for weddings, parties, concerts and shopping center entrances.

Rubb TM tension membrane canopies can be designed to fit almost any structure. One of the company's latest commissions to be completed was a tensile membrane entrance feature at Imperial House Science Park at Newport Gwent, UK. Current UK projects include a variety of applications such as a fabric roof for indoor tennis courts in Huddersfield, a sculptural entrance feature at Oxtalls Sports Club, Gloucester, a stainless steel trellis at Mile End Park, London and the replacement of an air supported dome at Cheltenham.

RUBB WATERTANKS

A prototype 1,320 gallon portable pillowtank is currently being tested at the Rubb production facility on Bomlo Island in Norway.

Portable water tanks are one of a number of products which benefit from Rubb's experience in fabric membranes and which have been introduced into the Rubb product line in recent years.



Available in a wide range of capacities from 130 gallons to over 26,000 gallons, Rubb Portable Water Tanks are used extensively by aid organizations and the military throughout the world.

RUBB IS PUT ON THE SANFORD MAP

Not many organizations have the street where they do business named after them, but that's exactly what has happened for Rubb USA.

Earlier this year the City of Sanford, Maine named the road which runs alongside the company's factory, Rubb Lane.

Speaking about the new address David Nickerson, Vice President and General Manager of Rubb, Inc. said: "After 17 years at this location it's great to finally make it to the Sanford map".



Rubb - on the map



The Rubb structure is intact after a severe fire in a paper storage warehouse

Rubb passes the FLAME TEST

At 3 am on a November morning in 1999, a fast spreading fire engulfed a Rubb storage facility at the Merrill Marine Terminal in Portland, Maine. A stray spark caused hundreds of bales of scrap paper to ignite as fire swept through the 82' x 120' structure; one of four Rubb buildings at the terminal.

The fast spreading fire vaporized the Rubb PVC membrane allowing heat and smoke to escape and thereby preventing heat damage to the steel framework of the building. Fire personnel were able to fight the fire safely and effectively from outside the structure. Amazingly, the structure was back in service with a new PVC membrane in less than a week following this severe fire.

As Rubb's client Mr. P.D. Merrill commented after the event: "Any other building would have been a total disaster - a total loss. We simply put new fabric on the building and it was back in service in less than a week".

This real life fire situation served to reinforce the results from an earlier full scale fire test of a 40' x 50' x 23' Rubb membrane structure conducted by Factory Mutual Research Corporation (FMRC) Test Center located in West Gloucester, Rhode Island.

The test structure consisted of a galvanized steel tube frame set on I-Beams anchored to the floor. The covering was 28 ounce per square yard PVC-coated polyester fabric tensioned over the framework.

For this test, instrumentation was used to measure fire signature data and to obtain information regarding fire detection response. Inside the structure, ionization and photoelectric smoke detector pairs were installed at two ceiling locations and fast response and standard response sprinkler heads were installed at four locations but not connected to a water source.

The fire was set in one corner of the test structure utilizing the fire source prescribed by the FMRC Approvals Division Building Corner Fire Test protocol. This required a 5' high, 750 lb. pile of hardwood pallets, 17 in total, as an exposure

fire for evaluation of wall and ceiling building materials. The fire source was positioned in the corner of the test structure. The first smoke detector activated 24 seconds after ignition and, although the fire penetrated the wall closest to the fire before the sprinkler actuated, all installed sprinklers actuated before flames compromised the adjacent south wall and the ceiling over the fire source location. Crucial to the continued life of the steel structure was the fact that the building PVC self-vented and interior temperatures were significantly reduced. This was exactly the experience of the Merrill fire, thus saving the steel structure for a new membrane cover. In a fully steel clad structure interior temperatures would be expected to reach higher levels and structural failure would be more likely. In aluminium frame fabric structures or thin wall steel structures heat effects would be more damaging than in a Rubb structure.

After severe exposure of the test structure to the fire source for a 15 minute duration, the fire test was concluded with no self-sustained propagation of the fire by the fabric covering and no fire damage to structural support members.

In addition to the laboratory scale flammability tests were also performed on the 28 ounce Rubb membrane fabric to measure heat release and ease of ignition properties. In the conclusion the Factory Mutual Corporation commented: "Fabric used for construction of the tension supported membrane structure evaluated during this program will not propagate flame or sustain combustion when exposed to a severe fire. Only the fabric immediately adjacent to the flaming fire source became involved in the fire."



... and 1 week later, complete with new membrane

Smoke detectors will provide early warning against fire prior to burn-through or venting of the structure. If a severe fire occurs in close proximity to walls, burn-through of the exposed walls is likely before a sprinkler can actuate. However, sprinklers would likely actuate prior to burn-through of the ceiling fabric."

Only last year the components of Rubb buildings were analyzed in further stringent fire tests in the UK. Rubb products have now been accredited with BS 7157 as further proof in satisfying current building regulations.

Rubb has recently produced a fire performance videotape which details the Merrill Marine Terminal Fire. This videotape, together with the Factory Mutual test video, are available to assist with understanding the fire performance characteristics of the Rubb product.

RAPID DEPLOYMENT SHELTERS for British Army

After supplying the British Army with 85 personnel shelters to meet the severe winter weather conditions of Bosnia, Rubb has further developed its product range to meet new military requirements.

In line with the creation of Britain's new Rapid Deployment Force, Rubb has created a range of RDS - Rapid Deployment Shelters. The original product was manufactured to meet United Nations requirements for Sierra Leone when a total of 115 20'x20' shelters were needed within an 8 week period.

For the British Army there are four main benefits to the RDS. The shelters pack to a small volume and are therefore easy to transport (up to 29 individual shelters can be stored in one 40' container). Each shelter can be fully erected within 2 hours by a team of 4 men with no requirement for heavy lifting equipment. Once erected, the shelters can be interlinked to form larger facilities and come complete with ground sheet, flooring and an easy to install lighting system. In addition, the shelters can be climatically controlled to meet a variety of worldwide conditions. The RDS is a direct result of Rubb's policy of continuous

Rubb Aquaweights show the strength of PVC

Building on the success of Rubb's 3 and 5 ton aquaweights comes the newly developed and tested 10 ton version.

Aquaweights are the latest products to be added to the Rubb product line. They incorporate Rubb's substantial experience in fabric structures and are engineered and tested with a 5:1 safety factor.

Rubb aquaweights are ideal for testing the capabilities of cranes in areas where it is impractical to use concrete weights, such as the marine industry. Aquaweights are becoming increasingly popular for use on ships and offshore oil installations where water is easily accessible and where the strength, light weight and durability of Rubb PVC are a big advantage.



New 10 ton Aquaweight undergoes testing and passed, proving the strength of Rubb PVC



A total of 115 RDS shelters were supplied to the UN within 8 weeks

research and development to help meet the changing requirements of battlefield infrastructure. The RDS is available in both lightweight and heavyweight versions to meet varying weather requirements.

Rubb TANK COVERS for E.P.S. at Dundalk

Rubb Buildings UK has completed a contract for the design, production and installation of two large 106 foot diameter covers for the control of odors generated by effluent treatment.



Odor control at Dundalk, UK

Each cover is constructed of a hot dip galvanized steel structure which is mounted onto the concrete walls of the tanks. The galvanized steel is provided with an epoxy paint finish to prevent corrosion of the framework and the framework is clad with Rubb's high strength PVC coated membrane.

"Rubb tank covers can be manufactured to any size from 20 feet to 130 feet" commented Ian Mackley, Technical Sales Engineer for Rubb Buildings. "In addition to their use for odor control they also provide a cost effective solution for maintaining potable water by prevention of algae growth and helping to stabilize the treatment process within the tank."

Hangar success for RUBB IN SCOTLAND



The Rubb organization, a world leader in the design, development and manufacture of relocatable structures, has a reputation with national and international airlines for the construction of relocatable aircraft maintenance hangars.

Rubb Buildings UK has recently completed construction of a new relocatable service hangar for Scot Airways in Dundee, Scotland. This contract follows similar projects in the UK for Brymon Airways at Bristol and City Flyer at Gatwick.

Measuring 90' x 100', the Scot Airways hangar consists of Rubb's standard hot dip galvanized steel frame covered with a flame retardant self extinguishing high tenacity PVC coated polyester fabric, which has a life expectancy of at least 20 years. Rubb was responsible for the design, manufacture, assembly and all mechanical systems relating to the Dundee project.

"We are extremely pleased to have completed the project at Dundee," said Rubb Sales Manager Ray Colby. "This is

our first commercial aviation contract in Scotland, although we have previously designed and erected hangars for the RAF at Kinloss and Lossiemouth."

"More and more airlines, like Scot Airways, appreciate the fact that Rubb buildings allow for future relocation and extension if required, since the structures can be erected and dismantled so easily."

Scot Airways General Manager, Brian Hetherington commented: "Rubb was responsible for the design, manufacture, assembly and all mechanical services relating to the hangar. The project was completed to deadline and the hangar is already proving of great use to our company."

Across the Atlantic, Rubb USA is currently undertaking a large hangar project at Logan International Airport in Boston, Massachusetts. Progress on this 255' x 270' hangar for United Airlines' Boeing 777/747 aircraft may be viewed on Rubb's web site at www.rubb.com



Rubb cleared for take off - our commercial aviation project in Scotland

Rubb has the answer for bulk storage requirements

The Port of Workington UK is now benefiting from the ability to provide high quality storage requirements thanks to the recent construction of two relocatable Rubb buildings; 82' wide x 105' long and 82' wide x 200' long. These structures provide storage facilities for animal feed, which needed to be completely secured against weather and light. There was also a design requirement for the units to provide a split storage capability.

Ray Colby, Sales Manager at Rubb UK explains the solution to the client's problems: "Because that part of the west coast of England is susceptible to severe winds and rain we constructed our storage systems on top of 13' retaining walls."



Animal food storage facility at Workington, UK

"The walls consist of a steel support structure complete with pre-stressed concrete infill panels which allow for quick and easy construction. This method provides a fully sealed facility to prevent water ingress and also allows for internal retaining walls to be built for different storage needs."

"The client required a dark covered structure as animal feed is susceptible to light, however translucent PVC material can be used to provide a brighter working environment without the need for windows."

Apart from the advantage of lower costs and speed of erection (the contract was completed within 4 months), Rubb buildings are flexible enough to be built on ground susceptible to differential settlement and have much lower maintenance costs than traditional bulk storage facilities.

Rubb joins forces with ROLLS ROYCE

Versatile and durable are two words used repeatedly when describing the structures manufactured by the Rubb Organization.

And, when Rubb Buildings UK was recently asked by Rolls Royce Aeroengines Ltd. in Nottingham to produce two structures to house a \$3 million turbulence control screen (TCS), versatility and durability were key factors.

Working within a very tight time frame, the Rubb UK team designed, manufactured and delivered two buildings in just eight weeks.

The first structure, an 80' long by 54' high stationary building with a 62' span was erected on a specially designed, reinforced concrete foundation. The building is now being used to house and maintain the TCS used in the testing of Rolls Royce aeroengines used in both military and domestic airplanes.

As part of the test, engines must be subject to the "smooth air" which is usually encountered thousands of meters up in the air. To create the smooth air effect, the engine is situated on a test bed with the TCS (which looks like a huge golf ball) over the front. The air, which is then drawn through the engine, replicates the smooth air which is vital for "real life" testing of the engine when airborne.

The second Rubb structure is slightly smaller. Measuring 40' long by 42' high with a 46' span, this structure sits on a trolley and is wheeled over the TCS when testing is interrupted by rain or high winds or when testing is complete.

When selecting Rubb Buildings to undertake the work, Rolls Royce looked specifically at Rubb's proven track record for custom design, engineering and fabrication.

Indeed, the German associates of Rolls Royce were so impressed with the Rubb product that they are considering having Rubb UK assemble similar structures at a number of sites in Germany.

Speaking of the success of the Rolls Royce project Ray Colby, Sales Manager of Rubb Buildings, said: "We are delighted with the two structures at the Hucknall testing site."

"We were chosen by Rolls Royce because of our experience in constructing similar large buildings for organizations such as the Ford Motor Company and Swan Hunter Shipyard and they are very pleased with the work undertaken."



Trolley allows for the structure to be moved quickly if the weather changes

Imperial House Science Park at Newport in Gwent, UK.



improves the appearance of the material, extends its life and allows the material to be readily cleaned or washed by rainwater (self cleaning).

The topcoats are applied in different ways depending on the nature of the topcoat and the required thickness. Lacquers are sprayed on whereas thicker coatings are “knife applied” or laminated to the PVC.

The thickness of top coatings has a direct relationship with the longevity of the PVC membrane. Topcoatings will degrade over time leaving the PVC surface exposed to airborne pollutants, UV degradation, wind and weather. The presence of a topcoat also tends to inhibit the migration of the plasticizers which give PVC its elastic and flexible properties. Migration and degradation of these plasticizers cause the PVC to become brittle, to blister and delaminate.

Different types of topcoatings include acrylic solutions, PVDF solutions and PVF film laminations.

Acrylic Topcoat

This commonly used finish is also the most economical and most widely available. It is a thin, spray-applied solution which gives a transparent glossy finish to the PVC. The acrylic coatings have a good resistance to UV degradation. The thinness of the coating application means that this material is easy to fabricate and repair by high frequency or hot air welding.

Acrylic topcoats are ideal for fabrics that are used for temporary structures and demountable structures such as marquees, circus tents, track side curtains, rock concert venues and warehouses.

Example: Blue Zoo Aquarium Entrance Feature, Beijing.

Fabric specification FOR ARCHITECTS

Fabric Basics

Guide to specifying architectural fabrics.

A fabric structure's material selection, proper design engineering, fabrication and installation all work interdependently to ensure a sound and architecturally pleasing structure. The fabric material's role in the structure's integrity and performance makes the selection process especially important. This is particularly true of tensile and air supported structures as their membranes act as their framework to carry the loads.

Membrane Materials

Most tensile structures utilize fabrics rather than meshes or films. The fabrics are typically coated and/or laminated with synthetic materials for greater strength and environmental resistance.

The most widely used materials are woven polyester cloths coated with polyvinyl chloride (PVC) and woven fiberglass coated with either polytetrafluoroethylene (PTFE) or silicone.

PVC Coated Polyester Materials

These are the most frequently specified materials. The polyester base cloth is used because of its durability, strength and relatively low cost.

The polyester fabrics are woven or knitted to high specifications to lend the fabric strength, visual consistency and measurable properties of stretch and strength. These properties allow engineers and designers to accurately predict the behavior and performance of the fabric before patterning and load analysis can proceed.

The polyester base cloths are then laminated or more usually coated with PVC to give the fabric color, strength and waterproof properties. The PVC coating also allows adjoining panels of fabric to be seamed by high frequency welding which provides a consistent high integrity joint that is superior in strength to the fabric itself. The PVC coatings are available in a wide range of standard colors. Custom colors are available at extra cost.

Topcoatings

Most architectural PVC polyesters have some sort of topcoating applied to their exterior or weathering surface. The topcoating

100% PVDF Topcoat

Polyvinylidene Fluoride (PVDF) is made up of fluoride, carbon and hydrogen. The compatibility of the carbon and fluoride is such that it offers a resistance to UV degradation and atmospheric chemical attack, which is far superior to the acrylic topcoat. Controlled exposure tests in Florida show that color differences and reduction in brilliance are significantly less with PVDF than with its acrylic counterpart over time.

PVDF topcoats also offer resistance to algae and fungal attack. They have good self-cleaning properties and therefore need less maintenance during their lives. These properties combine to give a membrane a life span of 15 to 20 or more years depending on site conditions and the initial quality of the membrane itself. Like acrylic topcoats 100% PVDF topcoats are highly flexible and resistant to cracking, making them easy to handle during installation.

The production procedures where the PVDF is chemically grafted to the PVC, as well as the polymers used, limits the choice of colors available. White is the only standard available color. Any other colors desired with this coating are limited and subject to special manufacturing runs, making them less economical.

The chemical-resistant properties of the 100% PVDF are such that the finished topcoated material cannot be welded to itself in its raw state. To effect a weld on 100% PVDF material the topcoating must either be abraded off or the material must be butt welded.

This extra operation increases the price of the fabrication and carries risks associated with the grinding depth calibration of the abrasion machine, and the complete covering of the abraded seam strip by the overlap. Inaccuracies in both these areas can significantly weaken the welded seam.

Site repairs are also difficult to administer accurately as they usually require manual abrading of the membrane using sandpaper. This coating is marketed under the trade names Fluotop and Kynar.

Example: Ashford Retail Outlet, UK.



PVDF/PVC Topcoating

This topcoating is effectively a dilution of the PVDF topcoat. This gives the advantages of being both more economical to produce and to fabricate. The saving in fabrication costs is derived from the finished fabric being weldable without need for abrasion. The diluted effect of the PVDF however means that environmental resistance is reduced along with longevity. This material is available in colors but is subject to minimum order manufacturing runs.

Example: Lords Cricket Ground Hospitality Unit, UK.

Tedlar Topcoating

Tedlar® is the DuPont registered trade name for polyvinyl fluoride (PVF). This is not a liquid topcoat. It is a film layer which is laminated to the PVC fabric during manufacture. This results in a thicker finished fabric which is more resistant than its competitors to weather and chemical attack. It has superior long term self-cleaning capabilities when compared to the PVDF range of topcoatings and will resist attack from graffiti, acid rain and bird droppings.

For this reason it is frequently specified for use in highly industrialized areas, marine coastal zones and desert environments.

Having a thicker coating, Tedlar erodes at a much slower rate giving it a life expectancy of about 25 years depending on conditions. The Tedlar film topcoating not only resists environmental degradation but also lessens the migration of plasticizers from the base PVC coating.

The Tedlar topcoating is flexible allowing a consistent and strong bond to the PVC. However, Tedlar's modulus of elasticity is such that it can be creased by folding and these lines can be noticeable up close.

Tedlar film is available in a wide range of colors which are subject to minimum manufacturing runs.

Like PVDF 100% topcoating, the Tedlar film renders the PVC sheet unweldable. This problem is addressed either with abrasion or by the application of butt welds.

Tedlar topcoated material is comparable in price to the PVDF equivalent but substantially more economical than PTFE coated glass fiber.

Example: UCLA Library, Los Angeles, USA.

PTFE Coated Glass Fabric

PTFE glass fabric is a frequently specified material due to its longevity. It has a life expectancy of approximately 30 years depending on conditions. Its base fabric is made up of glass fibers which are drawn into continuous filaments then bundled together in yarns. These yarns are then woven to form a substrate. The woven fiberglass has a high tensile strength, behaves elastically and does not undergo significant stress relaxation or creep. The glass fiber is also completely incombustible.

The flexing behavior of the glass is however inherently poor. This leads to cracking, poor handling ability and self-abrasion within the coating.

The PTFE or Teflon coating is also noncombustible. These coatings, being very inert, have a low coefficient of adhesion. This quality means that the coating itself has good self-cleaning ability. In the finished fabric however the self-cleaning ability is slightly diminished by the grainy surface of the membrane under tension, providing small indentations in which airborne solids can accumulate.

Most PTFE membrane is an off-white/brown color when it leaves the mill or fabrication plant. This discoloration bleaches to white in the presence of UV light. For this reason PTFE fabric should not be used indoors or in permanent shade without being pre-bleached. Pre-bleaching can be undertaken but it is expensive because it involves the material being cooked in an industrial oven for long periods at temperatures exceeding 250 degrees C. Although most PTFE cloths are supplied off-white it is possible to pigment the Teflon prior to coating.

The glass scrim combined with the bleached coating results in a fabric with good light transmittance.

Fabrication of PTFE membrane requires specialized welding

techniques under controlled environmental conditions. It also requires extra care in handling and packaging due to susceptibility to cracking and self abrasion. These properties contribute to its high cost and to the need for additional tensioning hardware for the finished fabric structure. The tensioning of PTFE glass fabric is a slow process, as it requires incremental adjustment over long periods on site. This factor also contributes to its cost.

PTFE glass cloth is often specified for high profile projects, for example, stadium roofs where longevity is required and where budget is not an issue. It is also suitable for desert and marine conditions found in places like the United Arab Emirates.

Other PTFE products include PTFE coated glass open mesh and PTFE coated glass mesh with a Teflon film laminated to it. These materials are used for translucent barriers and screens and for cladding purposes where the material is not contributing structurally to the finished structure.

Example: Millennium Dome Fabric Cladding, UK.

Other Frequently Specified Fabrics

Modified Acrylic

This is a woven acrylic material suitable for smaller structures with a limited life. Its degree of fire retardancy means that this fabric is only suitable for outdoor applications. It is available in a wide range of colors and is frequently specified for awnings and shade structures. It has a good resistance to discoloration and biological attack. Adjacent panels are joined by sewing.

Example: Walkway Canopies, Millennium Dome, UK.

Silicone Coated Glass Cloth

This material has a similar base cloth to PTFE glass membrane. However, the silicone coating gives the finished fabric a more flexible rubbery form. It therefore does not suffer from stress cracking in the same way.

The silicone coating is more economical and 100% fire proof. This finished fabric is available in a range of colors, widths and thicknesses.

The fabric is seamed by sewing or via an adhesive bond. Its high translucency and fire rating make it suitable for indoor tensioned ceilings and atrium shades.

Only the most advanced silicone coated fabrics have any self-cleaning properties, so it is not often specified for outdoor use.

Example: National Cowboy Hall of Fame, Oklahoma, USA.

Cottons

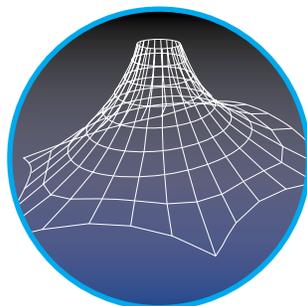
These materials are environmentally friendly and are easily dyed to any color. They can be treated to make them noncombustible and therefore suitable for indoor ceilings and exhibition structures. These materials quickly discolor in outdoor conditions, as they are vulnerable to biological attack. Unlike most other fabrics however, they can be laundered.

Example: Tensioned fabric ceiling at East Midlands Airport, UK.

Coated Nylons

Usually used for yacht sails and hot-air balloons, nylon has a high strength/low weight ratio making it suitable for very lightweight structures, drapes and exhibition work. It can be packed and folded without creasing and is available in a wide range of colors and coatings. Nylon can be fire treated, UV treated and waterproofed.

Example: Our Town Zone in the Millennium Dome, UK.





Screwfix expands with a little help from Rubb

Launch of NEW ARCHITECTURAL WAREHOUSES

In recent years Rubb has been able to meet the needs of a growing number of customers who opt for "hybrid" buildings which are supplied with hard walls and a PVC roof. Indeed, today architects are becoming increasingly involved in warehouse design and are utilizing the best of both technologies.

For example, in the south west of England, at Yeovil, Rubb Buildings met the urgent requirements of Screwfix to add storage facilities to meet their needs for expansion. The goal was to design and construct buildings which would both complement existing structures, and be quickly erected.

Two Rubb buildings were constructed with steel walls to match the other existing facilities, but with Rubb fabric membrane roofing. The highly translucent PVC roof material allowed staff to benefit from natural daylight when working in the facility. Two buildings were constructed, one 50' x 67', the other 50' x 133' joined as a twin link span.

Metal clad walls were recently supplied by Rubb USA for a United Airlines air cargo warehouse in Honolulu, Hawaii. At JFK International Airport in New York, United chose a Rubb Cargo Facility with concrete masonry block walls. At Rubb USA's latest United Cargo warehouse in Los Angeles, concrete tiltup panels are used to enclose the 136,000 square foot main Rubb warehouse.

Solid walls can provide both a fire rating and added security and

New cargo facilities at JFK International Airport, USA



can also provide insulation to meet cold conditions. A current example of this is the construction of the Rubb hangar at Logan Airport, Boston. Here 28' high walls are being constructed using insulated metal clad sandwich panels.

The development of these "hybrid" buildings has been a great success, because for all intents and purposes they are "conventional" buildings which customers continue to require. However, they have the benefit of providing an extremely light and airy working environment.

Shelter from the rain BERGEN NORWAY



Rubb Shelters prevent bad weather down time on the streets of Bergen

Rubb Building Systems is helping solve the problem of working in bad weather in Bergen.

In order to meet its launch as the City of Culture in 2000 the city had a number of important public works programs underway and due to inclement weather, time was running out.

To ensure that cobble stone work could be completed on an extremely tight deadline, two Rubb shelters were erected on the city streets. These enabled the workmen to continue their task whatever the weather. Both structures were 33' wide x 50' long and were readily moved by crane from position to position. Once set down the structures were held in position using concrete ballast weights.

High doors at each end of the shelter allowed for easy movement of personnel and equipment through the enclosures.



RUBB INC.

PO Box 711, Sanford Municipal Airport,
Sanford, Maine 04073 USA
Tel: 1-800-289-7822 Fax: 1-207-324-2347
info@rubbusa.com



RUBB BUILDINGS LTD

Dukesway, Team Valley Trading Est. Gateshead,
Tyne & Wear NE11 0QE, England.
Tel: 0191 482 2211. Fax: 0191 482 2516
info@rubbc.co.uk
RUBB TM LTD
Tel: 01453 884441. Fax: 01453 889181
info@rubbtm.co.uk



RUBB MOTOR A/S

Vetrlidsalm 4, 5014 Bergen,
Norway.
Tel: 55 315032. Fax: 55 317510
rubbnor@online.no

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